

II. AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in this

Application:

Listing of Claims:

1.-17. (Canceled)

18. (Previously Presented) Article of manufacture comprising:

a storage medium having a computer program encoded therein for causing an engine controller to control a direct injection internal combustion engine selectively operative in one of a homogeneous charge combustion mode and a stratified charge combustion mode and having an exhaust gas conduit fluidly connected to a NOx trap device said program including:

code to define a first engine speed/load operating region;

code to define a second engine speed/load operating region consisting of a reduced portion of the first operating region;

code to monitor engine operation;

code to monitor temperature of the NOx trap;

code to determine a cumulative mass of NOx stored on the NOx trap device;

code to operate the engine in the stratified charge combustion mode only when the engine operation is within the first operating region and the cumulative mass of NOx stored on the NOx trap device is less than a first threshold;

code to operate the engine in the stratified charge combustion mode when the engine operation is within the second operating region and the cumulative mass of NOx stored on the NOx trap device is greater than the first threshold;

code to control the engine-out air/fuel ratio to regenerate the NO_x trap when the temperature exceeds a predetermined temperature threshold; and,
code to control the engine in the homogeneous charge combustion mode and control the engine-out air/fuel ratio to regenerate the NO_x trap when the determined cumulative mass of NO_x stored on the NO_x trap device exceeds a second threshold, said second threshold greater than the first threshold.

19.-38. (Canceled)

39. (Previously Presented) Method for controlling regeneration of a NO_x trap comprising:

estimating an accumulated NO_x in a NO_x trap located in the exhaust path of an engine;
estimating a temperature of the NO_x trap;
determining whether the temperature of the NO_x trap exceeds a threshold temperature;
determining whether the estimated NO_x in the NO_x trap exceeds a second threshold value greater than a first threshold value, the second predetermined threshold comprising a fraction of capacity of the NO_x trap;
determining a desired air-fuel ratio for initiating regeneration of the NO_x trap, the desired air-fuel ratio being determined based upon one or a combination of the estimated NO_x stored within the NO_x trap and the temperature of the NO_x trap;
initiating regeneration of the NO_x trap when the estimated NO_x in the NO_x trap exceeds the second threshold value or when the estimated temperature of the NO_x

trap exceeds the threshold temperature by forcing homogenous operation of the engine at the desired air-fuel ratio;

hastening regeneration of the NO_x trap by reducing the size of a stratified charge operating region of the engine when the estimated NO_x in the NO_x trap exceeds the first threshold value and initiating regeneration when the stratified charge operating region of the engine is exited; and

wherein reducing the stratified charge operating region comprises reducing engine speed and engine load at which to operate the engine in stratified charge operating mode.

40. (New) Method for controlling a direct injection internal combustion engine selectively operative in one of a homogeneous charge combustion mode and a stratified charge combustion mode and having an exhaust gas conduit fluidly connected to a NO_x trap generally effective to accumulate NO_x emissions during lean operation of the engine and to release said accumulated NO_x emissions during rich operation of the engine comprising:

defining a first engine operating region as the only region in which stratified charge combustion mode is enabled;

defining an area of low engine speed and engine load, wherein stratified charge combustion mode is highly preferred;

defining a second operating region, comprising an area greater than the area of low engine speed and engine load and consisting of a reduced portion of the first operating region, the second operating region operative to redefine the only area in which stratified charge combustion mode is enabled;

monitoring engine operation;

determining a cumulative mass of NO_x stored on the NO_x trap device;
operating the engine in the stratified charge combustion mode only when the engine operation is within the first operating region and the cumulative mass of NO_x stored on the NO_x trap device is less than a first threshold; and
operating the engine in a stratified charge combustion mode when the engine operation is within the second operating region and the cumulative mass of the NO_x stored on the NO_x trap device is greater than the first threshold.

41. (New) The method of claim 40, comprising iteratively defining said second operating region, each iterative definition reducing said second operating region to a smaller area than the previous second operating region.

42. (New) The method of claim 40, wherein the first and second engine operating regions comprise engine operating regions defined in terms of an engine speed range and an engine load range.

43. (New) The method of claim 42, wherein defining the second operating region consisting of the reduced portion of the first operating region comprises reducing the engine speed range of the first operating region.

44. (New) The method of claim 42, wherein defining the second operating region consisting of the reduced portion of the first operating region comprises reducing the engine speed range and the engine load range of the first operating region.

45. (New) The method of claim 40, further comprising operating the direct-injection internal combustion engine selectively operative in the homogeneous charge combustion mode when the engine operation is outside the first operating region when the cumulative mass of NO_x stored on the NO_x trap device is greater than the threshold.

46. (New) The method of claim 45, further comprising regenerating the NO_x trap by controlling the engine-out air/fuel ratio to an air/fuel ratio rich of stoichiometry.

47. (New) The method of claim 46, comprising monitoring exhaust gas output from the NO_x trap, and, ending the regenerating of the NO_x trap when the monitored exhaust gas indicates a rich deviation of gases flowing out of the NO_x trap.

48. (New) The method of claim 46, comprising ending the regenerating of the NO_x trap upon expiration of a regeneration timer.

49. (New) The method of claim 46, comprising ending the regenerating of the NO_x trap when the engine operation falls below a threshold value for the engine operating region.

50. (New) The method of claim 40, further comprising:
monitoring temperature of the NO_x trap; and,
controlling the engine-out air/fuel ratio to regenerate the NO_x trap when the
temperature exceeds a predetermined temperature threshold.

Serial No.: 10/812,467

Filing Date: 3/30/2004

Office Action Date: 10/31/2007

Response Date: 2/29/2008

51. (New) The method of claim 40, further comprising operating the engine in the homogeneous charge combustion mode and controlling the engine-out air/fuel ratio to regenerate the NO_x trap when the determined cumulative mass of NO_x stored on the NO_x trap device exceeds a second threshold, said second threshold greater than the first threshold.